AEROSTATIC, AUTOMATIC SPECTROMETER WITH A DIFFRACTION GRATING OF AN AREA OF 0.2 - 0.4 MKM.

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Aerostatic, Automatic Spectrometer With a Diffraction Grating of an Area of 0.2 - 0.4 mkm.

High altitude experimental investigations of spectral reduction of direct solar radiation give information necessary for the study of the radiation system of the real atmosphere and for the identification of stratification of the optically active components.

During the last few years, the optical probing of the atmosphere obtained a still greater development. Investigations were executed mainly in the infrared region of the spectrum, saturated with the bands of absorption of polyatomic components but investigations of the spectral atmospheric transparency in a wide spectral interval including even short-wave solar radiation and investigations carried out in free atmosphere are few. Ascents in the complex of the spectral apparatus, which was developed in the department of atmospheric physics, to the height of 30 km allowed one to obtain a series of polar spectra in the interval of wave lengths from 0.36 - 13 mkm [1]. The ultraviolet region of the spectrum remained outside the limits of this interval, meanwhile the reception of information concerning the weakening of short-wave solar radiation is interesting both for identification of concentration of the ozone in various high altitudes and for the isolation of the aerosol component of optical density, whose selectivity in the short-wave region of the spectrum is most expressed. Recording of the ultraviolet region of the solar spectrum is connected with specific experimental difficulties. The main one is the elimination of diffused light in the spectral apparatus, which is closely dependent upon the disposition maximum of the spectral solar radiation distribution, which many times exceeds the intensity of radiation in the range being examined. Added to this difficulty are specific problems caused by the conditions of ascent: the necessity of continuous focussing of the image of the solar disk on the input gap of the apparatus which oscillates and rotates relative to the source of light; securing the functioning of the instrument in a wide range of temperatures and pressures; the necessity of automatic change in the sensitivity of the recording track produced by significant change in the high transparency of the atmosphere in the range being examined and so forth.

We note that the rejection of the dispersive screens usually applied, or of the short-focus (beaded) illuminator of the entrance gap and the illumination of the gap with the help of a long-focus objective which permits the elimination of the central part of the solar disc, while it imposes increased demands on the accuracy of tracking beyond the sun, nevertheless, permits one to concentrate sufficient energy on the gap to receive spectra with a resolution close to that theoretically possible for the applied optics of the monochromator. The rejection of the short-focus illuminator, which possesses a large, solid angle, also permits it to be free of the influence of dispersed radiation in the circumsolar corona, depending on aerosol dispersion.

We present below, a brief description of the spectrophotometer developed for short-wave radiation. The spectrophotometer consists of a spedular automatic control system [2] with a quartz objective, a specular monochromator with a diffraction grating, a receiver-recording tract and a program mechanism. In figure 1, the optical scheme of the spectrometer is shown. Solar radiation, reflected by

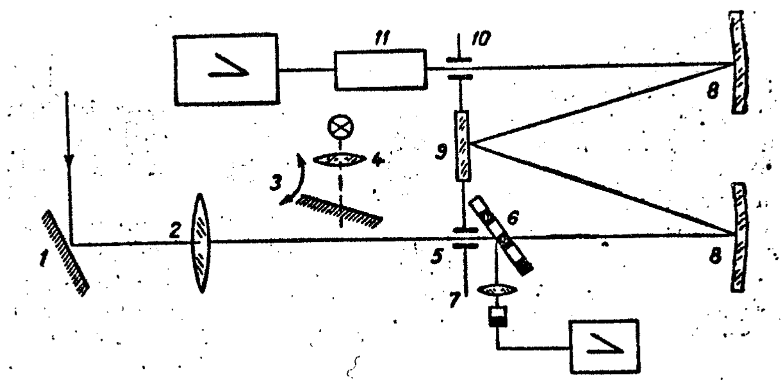

Fig. 1: Optical schematics of the spectrometer.

the revolving speculum of automatic control system 1, is brought into focus with the aid of quartz lens 2, which has a focal distance of 248 min., to the input gap of monochromator 5. The input gap is limited by additional blades and has a height of 1 mm. The rotating speculum 3 is placed in front of the input gap. With the admission of the speculum to the input gap is found specular obturator 6, which passes a luminous flow to the monochromator, or reflects it to photodiode 7; it is designated for controlling the application of the apparatus to the sun by the alteration of the illumination with the undispersed solar light which passes through the input gap. The modulation frequency of the luminous flow is about 1 khz. In selecting the optical monochromator schematics, conditions were analyzed which create a false signal at the input of the spectrometer which is determined by diffused light. Actually, in the application of "blind" photomultipliers (in particular, photomultiplier - 57) of low sensitivity to the visible area of the spectrum, one may avoid double monochromatization. A simple verticle symmetric schematic, which has an advantage over the optical schematic of Evert-Fasti in relation to a lesser quantity of diffused light, is the most effective [3]. It is true that when the vertical-symmetric plan is applied, it is necessary to compensate for the inclination of the image of the input gap in the output surface.

The use in the monochromator of extra-axial parabolic specula with F = 270 mm and an extra-axial angle of 19^{o} permitted one to obtain a virtually aberrationaless image of the input gap on the output surface. A flat diffraction grating 60 X 60 mm in size has 1200 strokes per mm. The grating works in the first order. The photomultiplier PEM-57 has a maximum sensitivity or a wave-length of 0.25 mkm. The rapid decrease of sensitivity in the wave length compensates to a significant extent, for the increase of intensity of straight solar radiation. This permitted one to obtain spectra of the sun in a range of 0.2 - 0.4 mkm without change of sensitivity of the receiver-recording tract.

The power supply of the photomultiplier consists of a static transistorized converter, the tension in the converter output is 1600 volts. Directly in the outlets of the photomultiplier is assembled an emitter-repeater which is necessary for destruction of sightings of unwanted origin, the signal from it acts on the transistorized amplifier (fig. 2). The resonance amplifier has a transmission band of a half-width of 50 hz and with a linear detector outlet. The temperature of the amplifier is stabilized.

The switching of the sensitivity of the amplifier according to the ascent degree of the aerostat is accomplished with the aid of a block in the pressure relay. The signal is recorded by a circuit oscillograph K-12-12. Besides the spectra of the sun, are recorded the temperature of the apparatus and the temperature of the surrounding air, oberboard pressure, time indicators obtainable from electric clocks, reference marks of the resolution of the spectrum, pressure supplied to the calibrating source of light, pressure of the power supply of the amplifier and the high voltage converter.

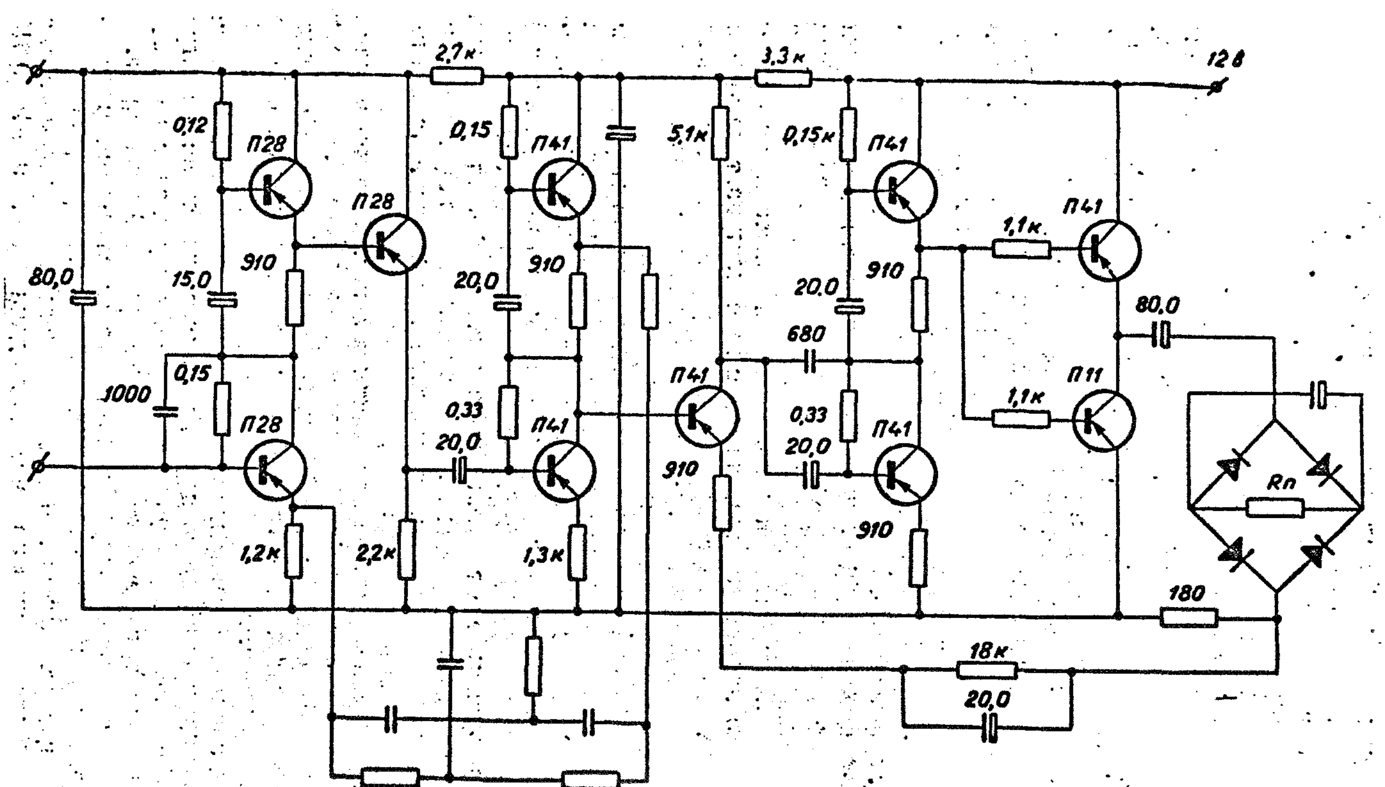

Fig. 2: Schematic of the transistorized amplifier.

The scanning of the spectrum is made with the aid of the cam-mechanism connected with the program cams. The scanning rate of a region of 0.2 - 0.4 mkm is about 30 sec. The automatic control system functions at a frequency of 400 hz with an improved static generator. The entire apparatus is placed in a foam-layer container, on the upper lid of which is found a switch and control panel of the functioning of the apparatus. The automatic control system is connected to the body of the monochromator and protrudes above the upper lid of the container.

An evaluation of dispersed light within the monochromator was made. Measurements were made with the aid of light interference filters, which separated the various sections of the range being examined. It was determined that for wave lengths of 0.294, 0.313, 0.335 mkm, the fraction of dispersed radiation did not exceed $\sim 10^{-5}$. If one assumes that this order is valid for the whole investigated area, then at a height of 35 km, the dispersed light should amount to 1.7%. Moreover, the dispersed light is also estimated directly by the solar spectra. For example, an area of the solar spectrum near 0.260 mkm in connection with virtually complete absorption in the atmosphere at altitudes up to 30 km may be used for estimating the change in dispersed light with altitude.

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